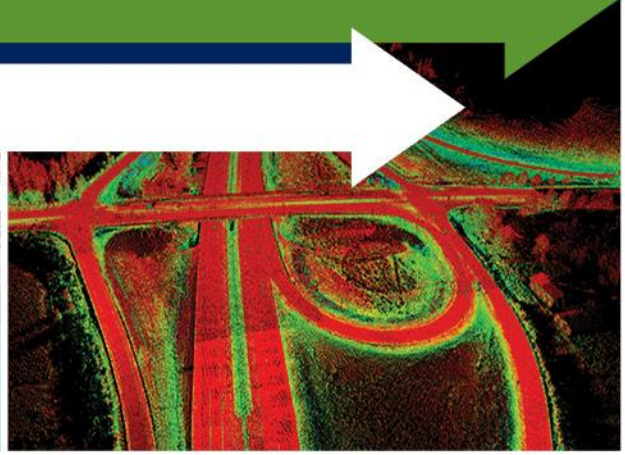
BIM for Bridges

Doug Dunrud, PE
Senior Bridge Engineer



U.S. Department of Transportation
Federal Highway Administration

EDC-3 3D Engineered Models:
Schedule, Cost and Post-Construction

What is BIM?

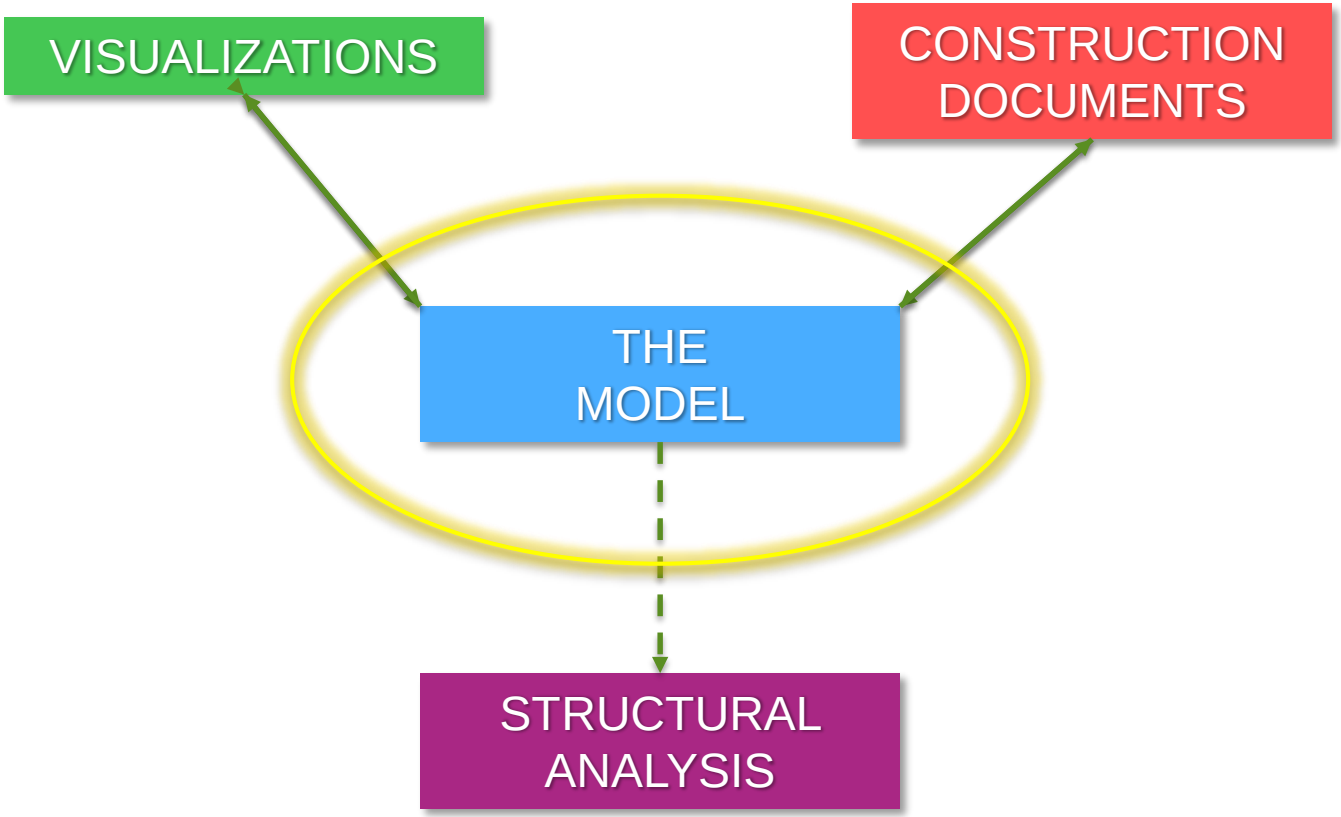
- *Building Information Modeling*

If “Building” is understood as a verb rather than a noun, then BIM can refer to everything related to construction including Transportation Infrastructure.

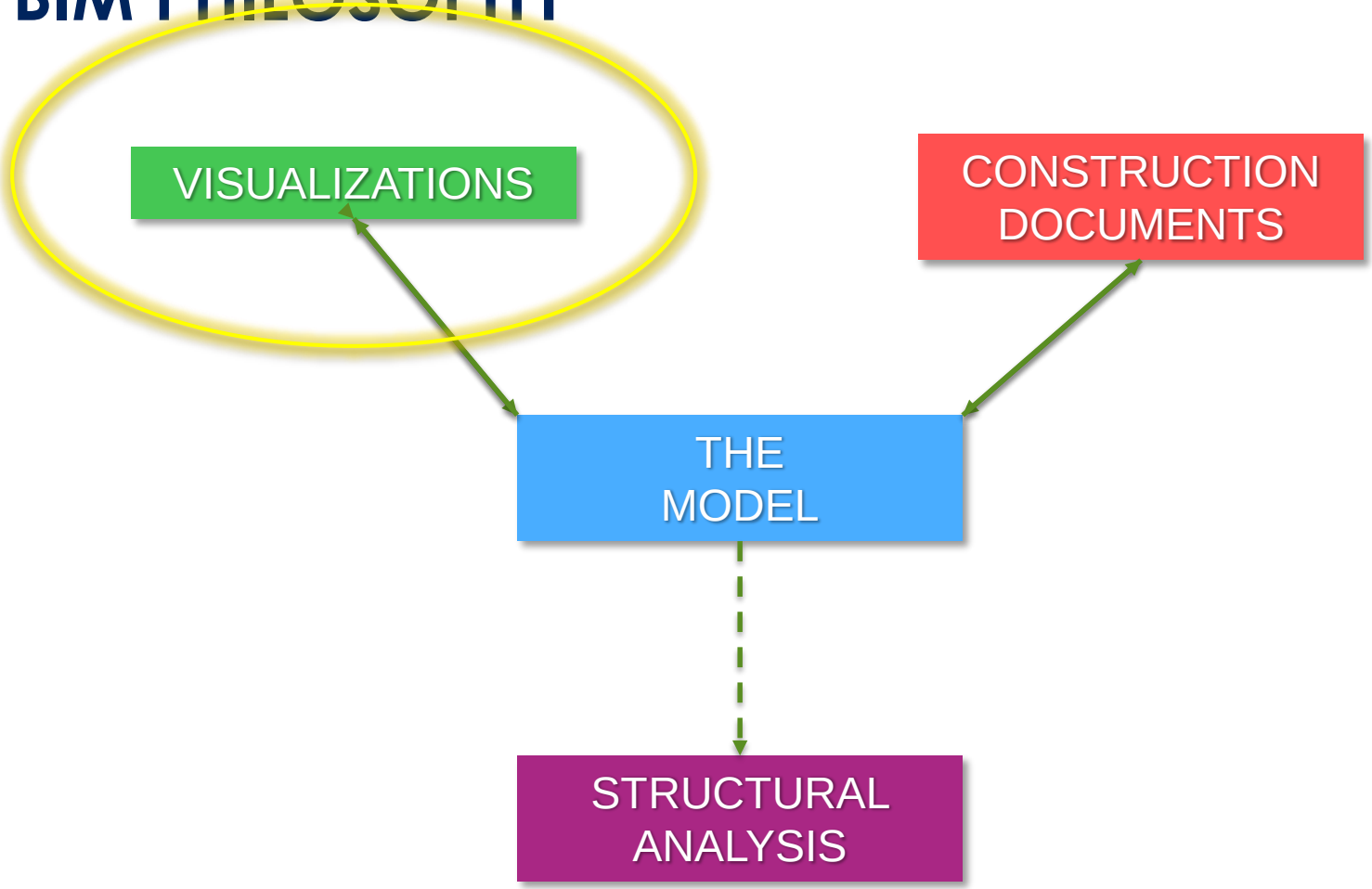
Caltrans Structures State of the Practice

- Workflows are being developed to utilize the 3D models for visualizations, construction documentation (plans and quantities) and for structural analysis.
- The goal is to improve collaboration, efficiency and quality.

BIM PHILOSOPHY



BIM PHILOSOPHY



I. VISUALIZATIONS

- Why use 3D Models for Visualization

I. VISUALIZATIONS

- Why use 3D Models for Visualization

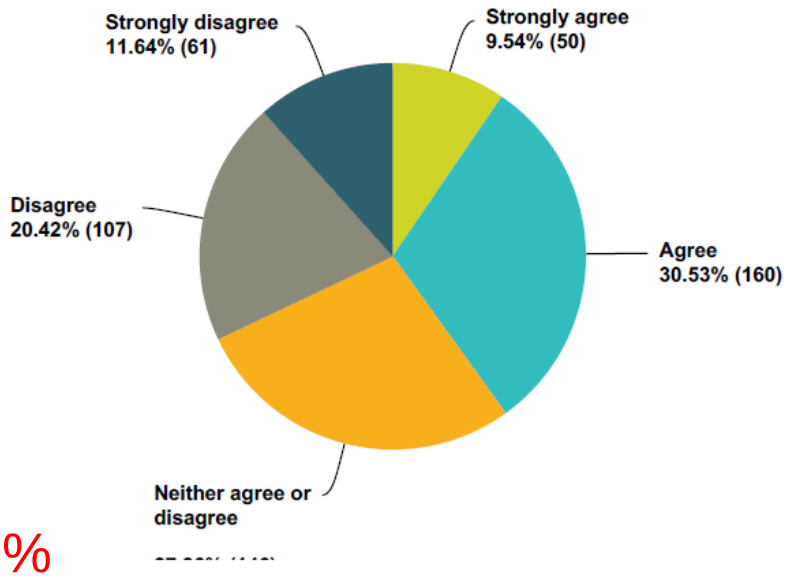
Goal 5: Organizational Excellence (continued)

Strategic Objectives	Performance Measures	Targets
Cultivate an environment that encourages proper identification, management, and communication of risk across all levels of the organization and	Create a risk management campaign that increases the Department's level of risk maturity according to industry standards.	By 2020, designated risk management processes and functions can be assessed as Level 4 "managed" or Level 5 "leadership" under an industry standard risk management maturity
	Percentage of divisions that have implemented one or more workforce planning strategies by 2020.	By 2020, 100% of Caltrans occupational groups have adopted at least one workforce planning strategy.
Improve collaborative partnerships with agencies, industries, municipalities and tribal governments and advance national engagement with the transportation research and policy committees.	Percent increase in the number of partners who agree or strongly agree that Caltrans is a collaborative partner. 75%	By 2016 (or next survey date), increase to 75% the percentage of partners who agree or strongly agree that Caltrans is a collaborative partner. Through 2020, maintain or increase the percentage every year.

2015 Caltrans External Stakeholders Survey

Q8 Based on your overall experience with Caltrans, Caltrans is a collaborative partner.

Answered: 524 Skipped: 47



40%

	Strongly agree	Agree	Neither agree or disagree	Disagree	Strongly disagree	Total	Weighted Average
(no label)	9.54% 50	30.53% 160	27.86% 146	20.42% 107	11.64% 61	524	0.00

Project 20-07/Task 351, FY 2014

Update to AASHTO's Visualization in Transportation: A Guide for Transportation Agencies

FINAL GUIDE

PREPARED FOR NCHRP
TRANSPORTATION RESEARCH BOARD
of
THE NATIONAL ACADEMIES

Kevin Gilson, Director of Visualization-Parsons Brinckerhoff
Charles Hixon, Director of Business Development-EDGE-Global Technology Solutions

Denver, CO
July, 2015

Abstract

The purpose of this project was to update the *AASHTO Visualization in Transportation: A Guide for Transportation Agencies* (Guide). The AASHTO Technical Committee on Environmental Design (TCED) developed the Guide in 2001 and updated it in 2003. Those documents have provided valuable assistance to State Departments of Transportation (DOTs) across the country that are seeking sound information, guidance and technical assistance on visualization.

The usage of visualization within transportation agencies is now more widespread and established, and visualization technologies and processes have advanced considerably. The need for context-sensitive solutions for transportation projects requires visualization tools that represent those projects accurately and realistically in their intended environments. The concept of transparent communication of project goals and impacts has lead agencies to embrace visualization for stakeholder communication. Visualization tools foster better communication and collaboration, which can lead to mutually-acceptable results faster, while achieving better project outcomes.

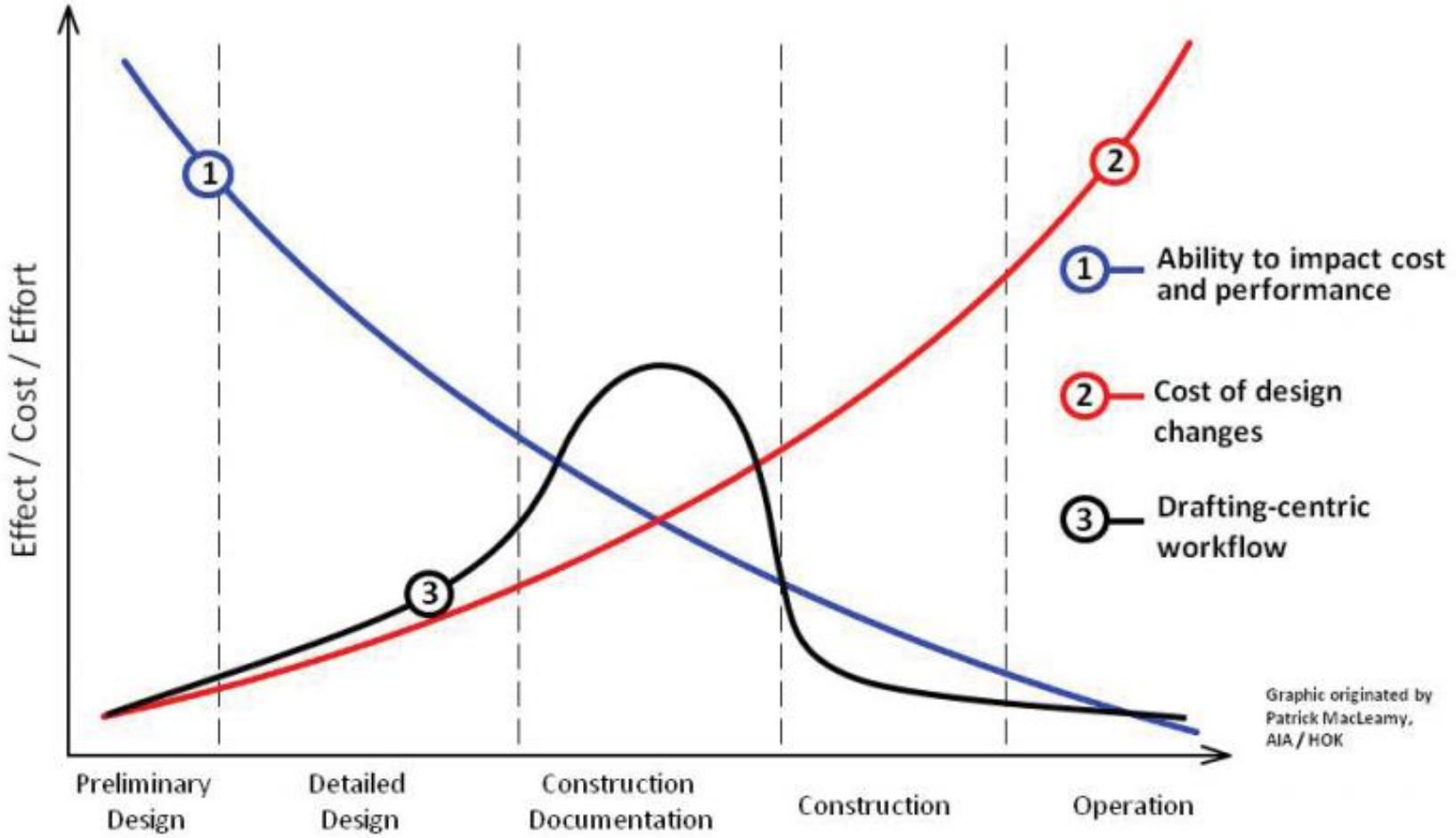
This updated Guide represents research into new technological advancements, processes, techniques and includes applicable case studies. It is intended that this Guide will become a valuable reference for the transportation community — a current, nationwide publication that will provide comprehensive technical and practical guidance for visualization in transportation.

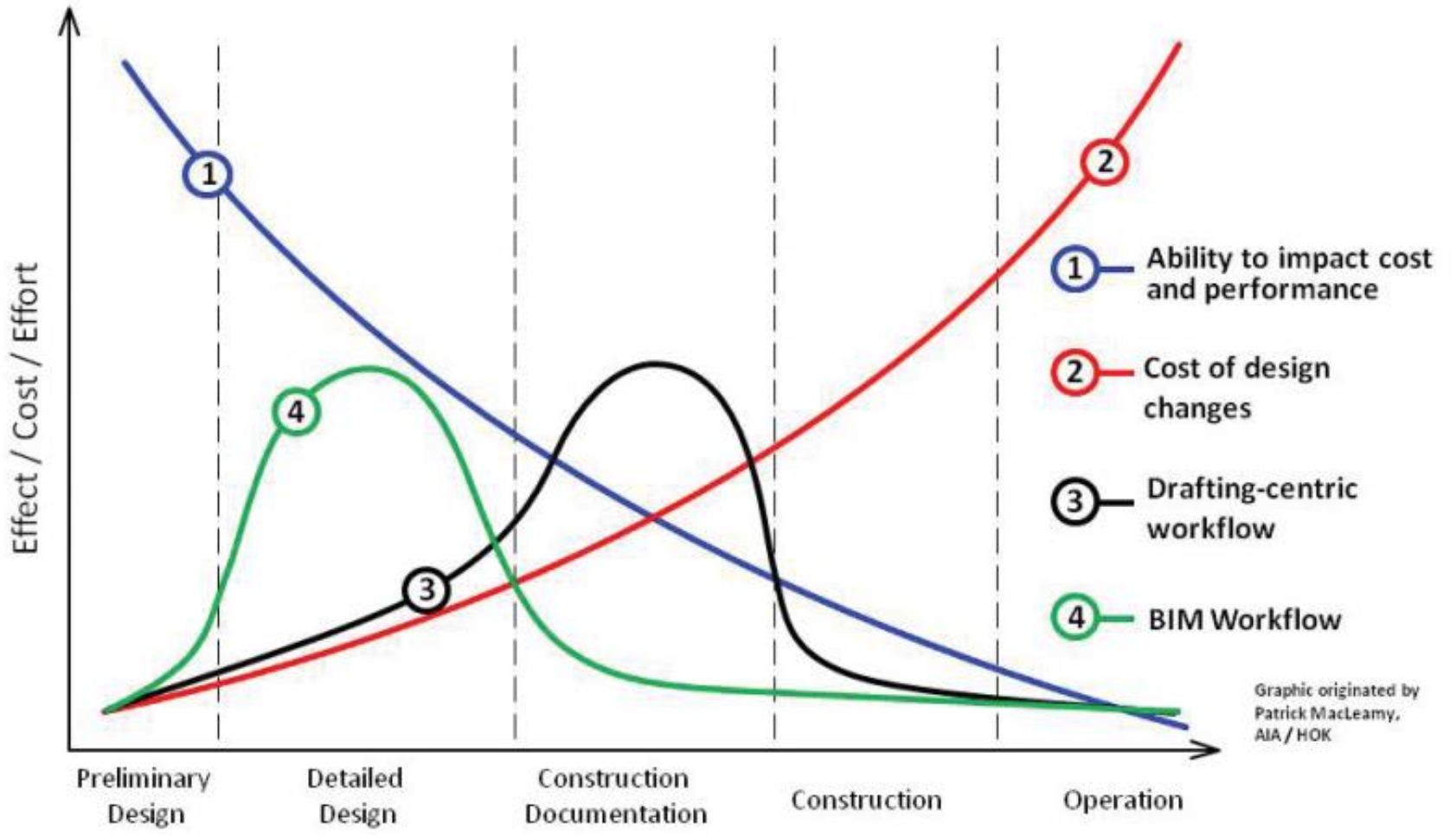
Why the Need for Visualization?

SAFETEA-LU Requirements

Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) establishes that Metropolitan Planning Organizations (MPOs), "to the maximum extent practicable, employ visualization techniques to describe plans." (Source: SAFETEA-LU, Public Law 109-59)[4]

The Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) have jointly issued rules for MPOs to follow in order to meet the requirements established in SAFETEA-LU. The FHWA and FTA define "visualization techniques" as "methods employed by states and MPOs in the development of transportation plans and programs with the public, elected officials, and other stakeholders in a clear and easily-accessible format." This is intended to "promote improved understanding of existing or proposed transportation plans and programs." The FHWA and FTA language is intentionally vague in regards to the types of visualizations that are appropriate or expected. As a result, each MPO is allowed the flexibility to meet visualization requirements in a way that most "appropriately [illustrates] the projects or plans."


Effect / Cost / Effort
1
2
3
Ability to impact cost and performance
Cost of design changes
Drafting-centric workflow
Graphic originated by Patrick MacLeamy, AIA / HOK
Preliminary Design
Detailed Design
Construction Documentation
Construction
Operation


Effect / Cost / Effort
1
2
3
4
Ability to impact cost and performance
Cost of design changes
Drafting-centric workflow
BIM Workflow
Graphic originated by Patrick MacLeamy, AIA / HOK
Preliminary Design
Detailed Design
Construction Documentation
Construction
Operation


APN: 061-0-160-235
OJAI VALLEY LAND CONSERVANCY
APN: 035-0-120-255
RANCHO ARNAZ
APN: 061-0-160-245
VALLEY, OJAI CONSERVANCY
APN: 061-0-160-255
VALLEY, OJAI CONSERVANCY
APN: 035-0-120-100
WEISS, SCOTT ALAN WEISS, EVA PRINCE
APN: 035-0-120-265
WEISS SCOTT & EVA TR
APN: 035-0-120-220
RANCHO ARNAZ LLC
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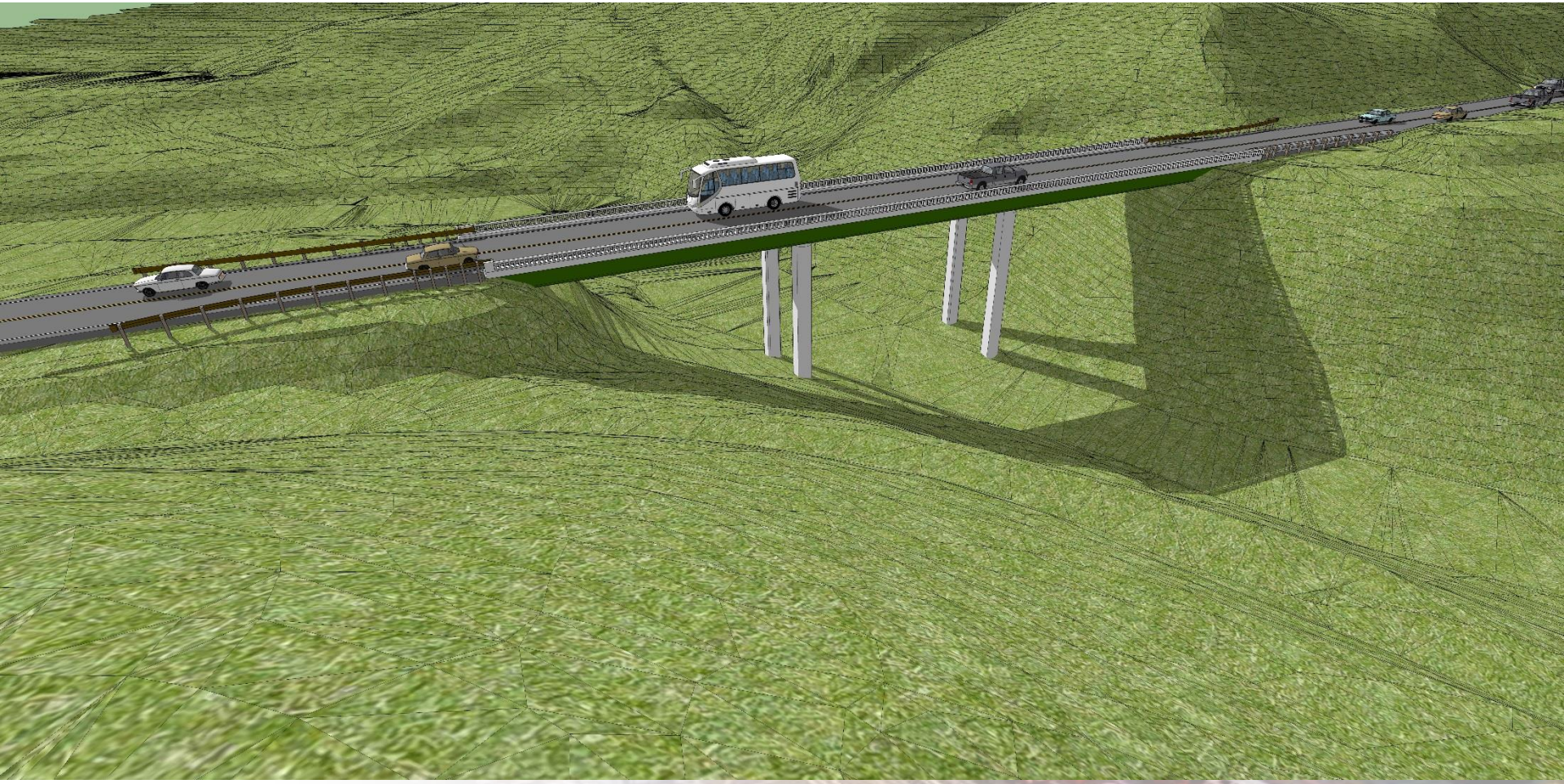
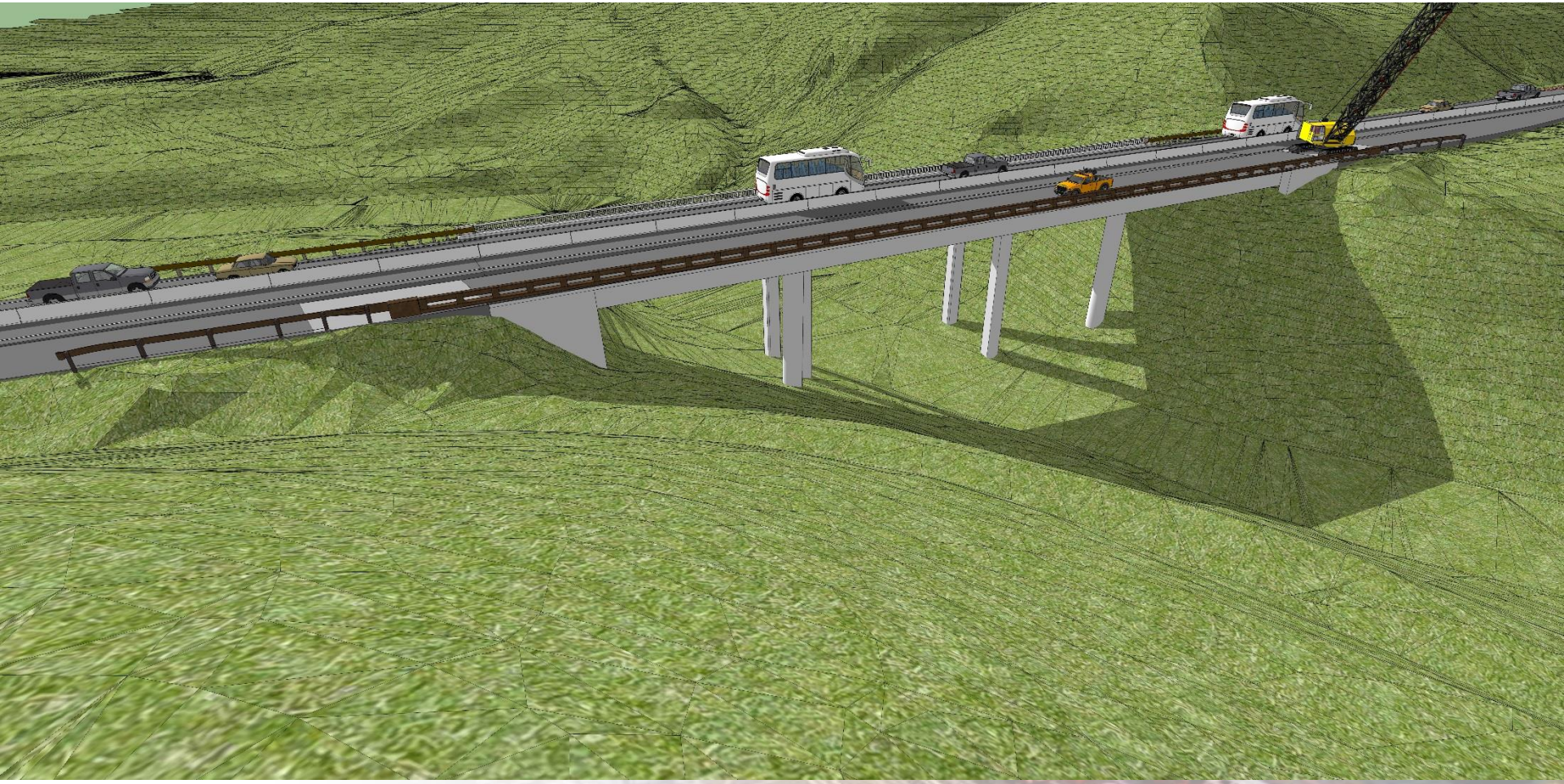
TRES CONDADOS GIRL SCOUT



Every Day Counts



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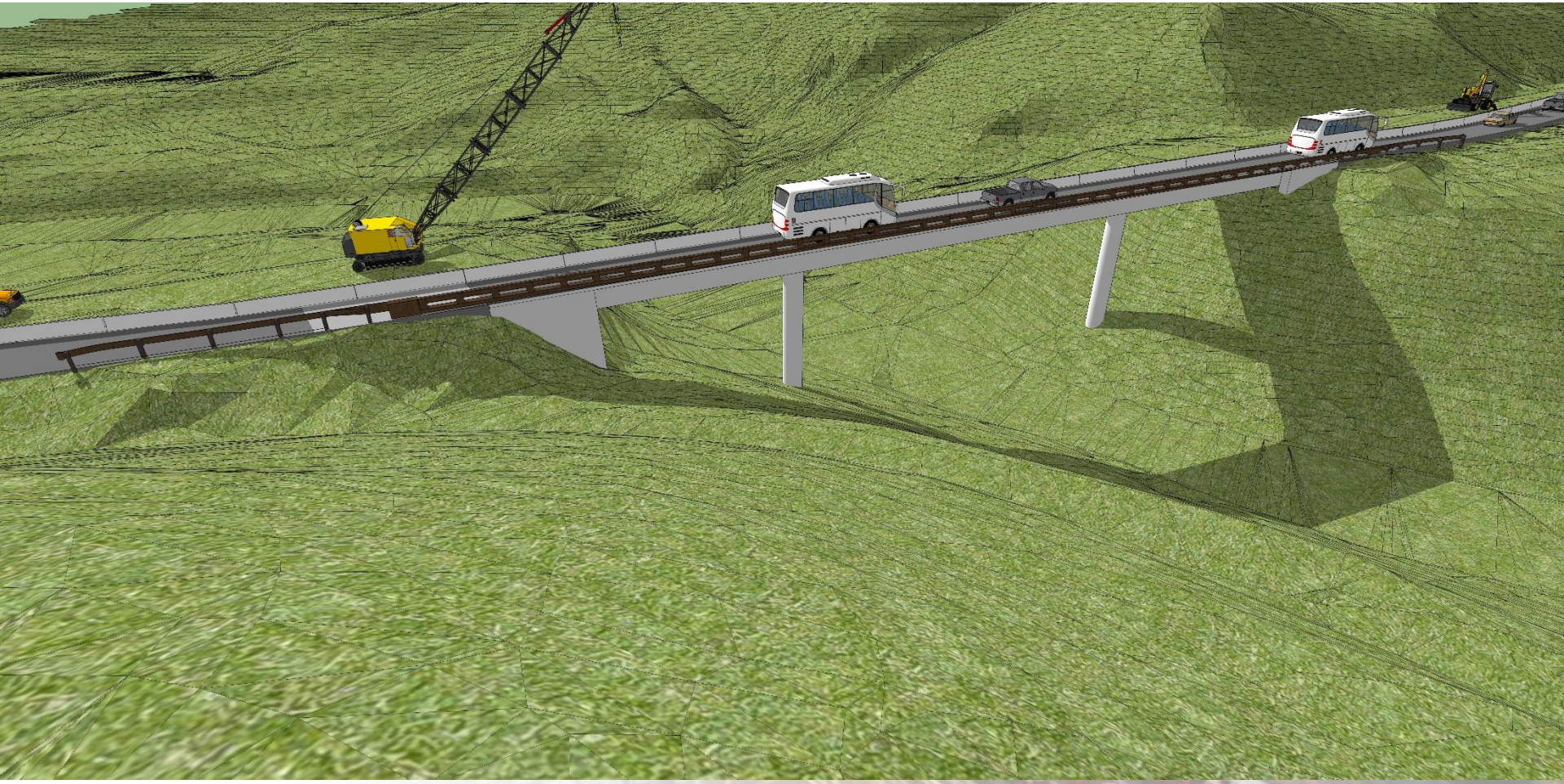
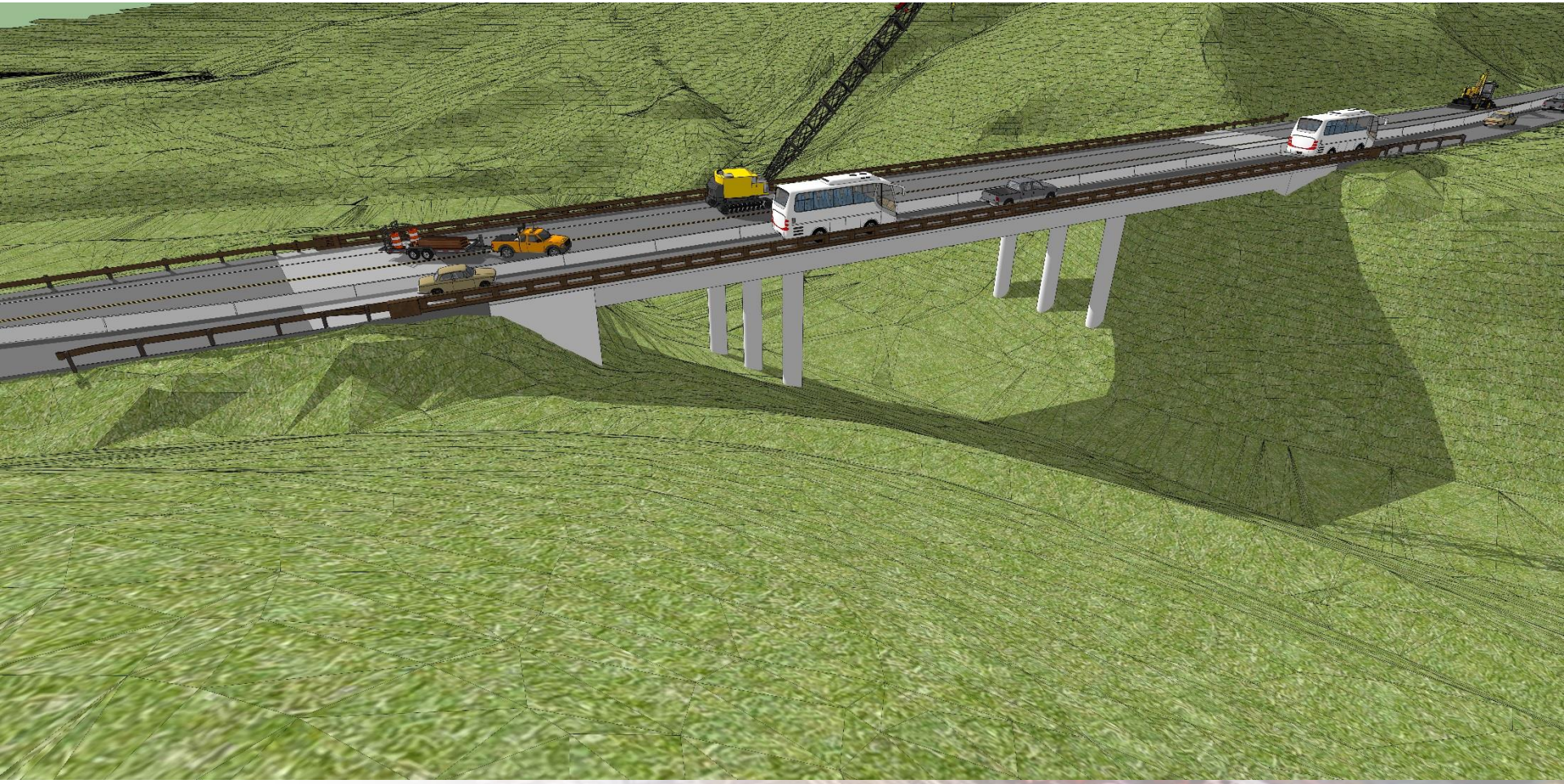


Every Day Counts



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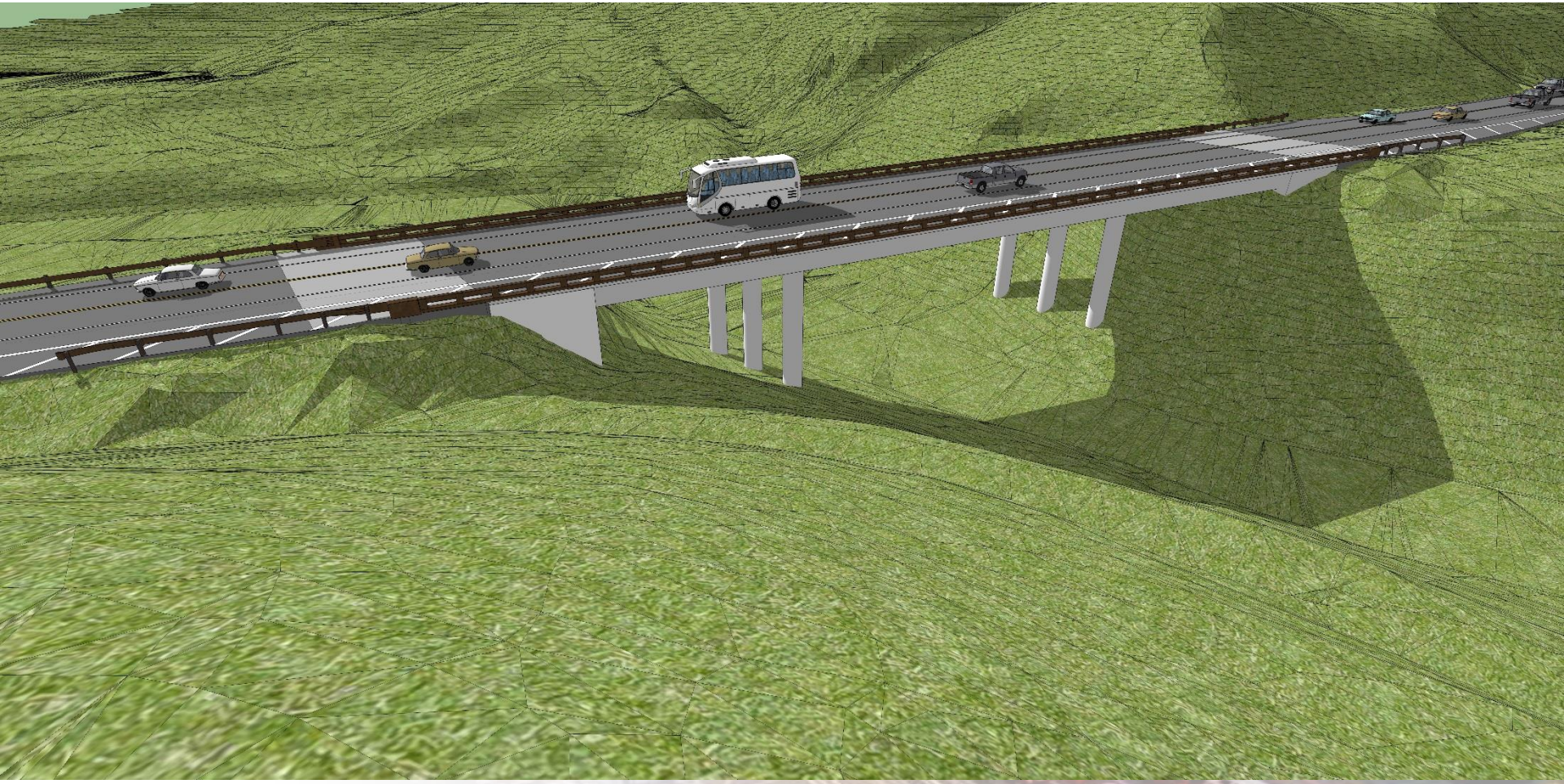


Every Day Counts

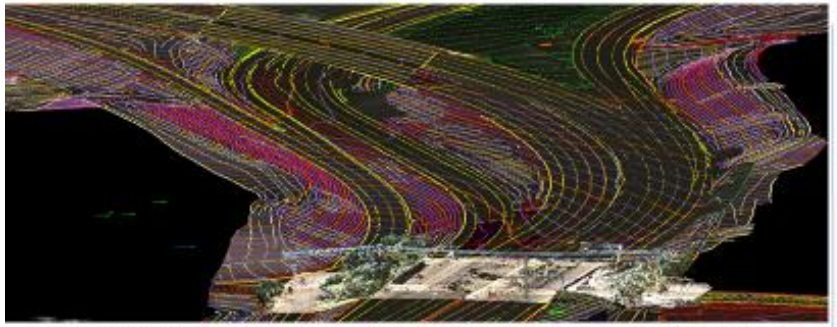


Photo Caption: Design grade Digital Terrain Model(DTM) overplayed with Mobile Terrestrial Lidar Scan (MTLS) point cloud for Alameda-680 express lane project

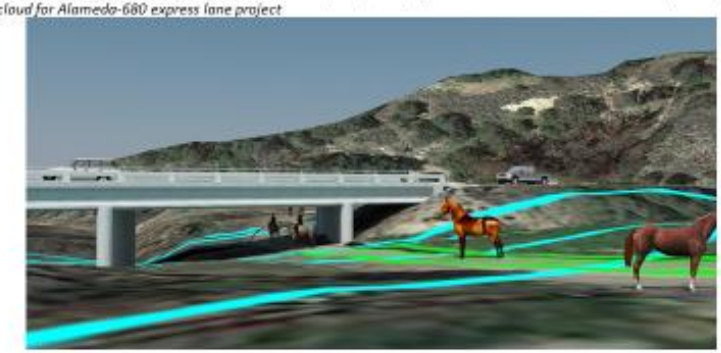


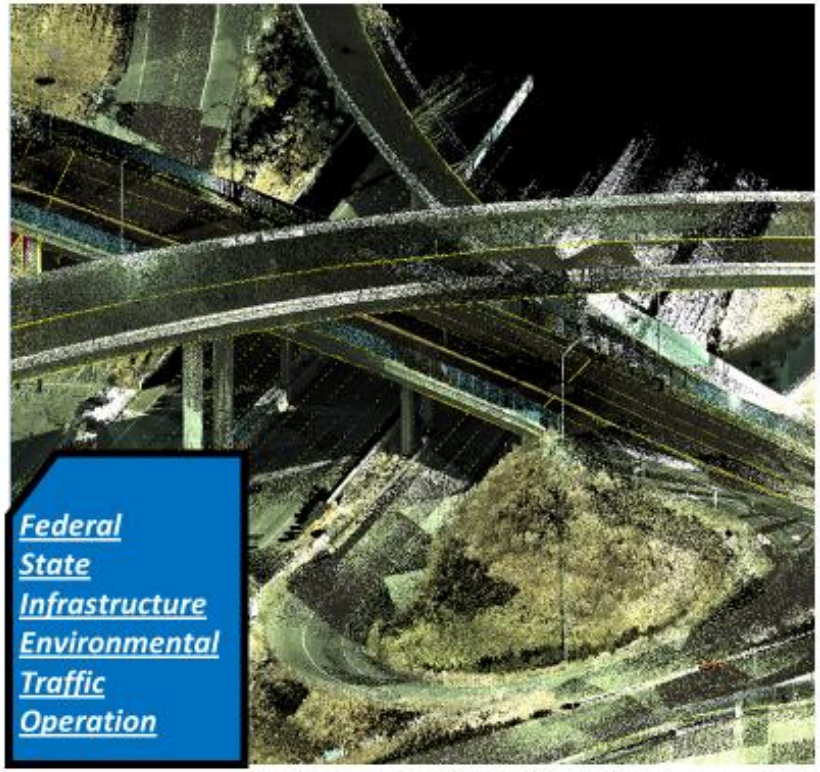
Photo Caption: The proposed project is located on State Route 33 (SR-33) at San Antonio Creek Post Mile 7.58, south of Ojai City in Ventura County

FEDERAL STATE INFRASTRUCTURE ENVIRONMENTAL

Caltrans is a leading DOT agency that is implementing Integrated Project Delivery (IPD) concept to establish the foundation for Caltrans Visualization Group(CVG) and virtual design construction Group (VDC).

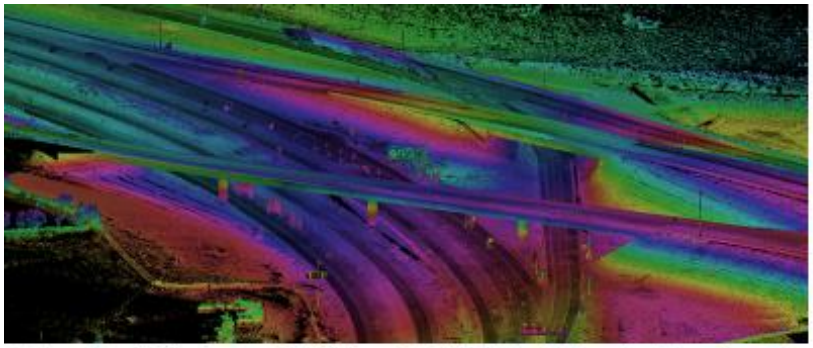
Doug Dunrud, PE
Senior Bridge Engineer
douglas.dunrud@dot.ca.gov

Caltrans Visualization Group (CVG)



Federal State Infrastructure Environmental Traffic Operation

Every Day Counts



Caltrans Virtual Design Construction (CVDC) provides 3D digital models throughout the project delivery process to assist Caltrans project managers the tools to solve complex problems, simplify decision-making processes, and maximize the value of information. Our team have access to wide range of analytical geospatial and database tools and processes to simplify and solve complex problems.

- Able to understand and read plan reports and design plans.
- Must work seamlessly with the planning or design team.
- Knowledgeable with an array of visualization tools.
- The artistry needs to come from within.

EXPERTISE

CVG team has extensive experiences in handling and development of geospatial 3D central models to assist project development planning and design team to effectively utilize and provide assistance during all project phases.
Capabilities include and are not limited to analysis of imagery, Lidar Scan, geophysical surveys, roadway design, structure design, clash detection, and derivative data products from these data categories as necessary.

CVG team can provide the services required to derive high-quality 3D data products to meet the needs of any project.

SUPPORT SERVICES

- Autodesk Civil3D
- Autodesk 3DS MAX
- Bentley Microstation
- Bentley InRoads
- Leica Cyclone
- Trimble SketchUp Pro

Photo Caption(1A): Google Earth Street View

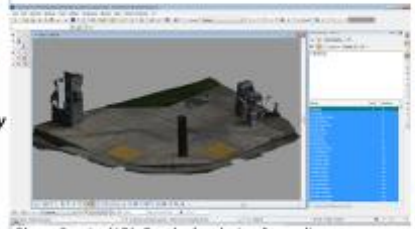


Photo Caption(1B): Bentley's solution for reality capture using Context Capture technology

PROJECT EXPERIENCE

Design survey grade 3D modeling of ADA Ramps

Caltrans engineering services has been researching on developing effective ways to optimize the survey data collection and processing cost and providing the best 3D digital data to design engineers for effective design process

Analyses Performed

- Change detection
- Horizontal & Vertical Accuracy
- Generation of point cloud and CAD

Software

- Microstation Select Series 3
- Autodesk Civil3D 2012

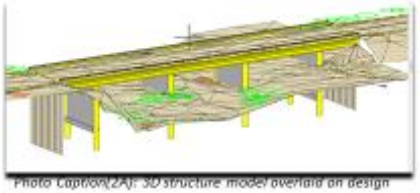


Photo Caption(2A): 3D structure model overlaid on design grade DTM

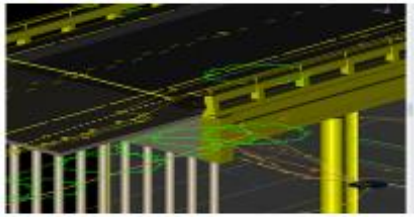


Photo Caption(2B): 3D structure model with BIM Level Of Detail(LOD) 300

PROJECT EXPERIENCE

San Antonio Creek Bridge 3D Visualization

Caltrans CVG team have been developing 3D Geospatial model that mash 3D digital data from various sources (i.e. GIS, 3D design grade survey, 3D structure, 3D roadway design, 3D point cloud data, ...)

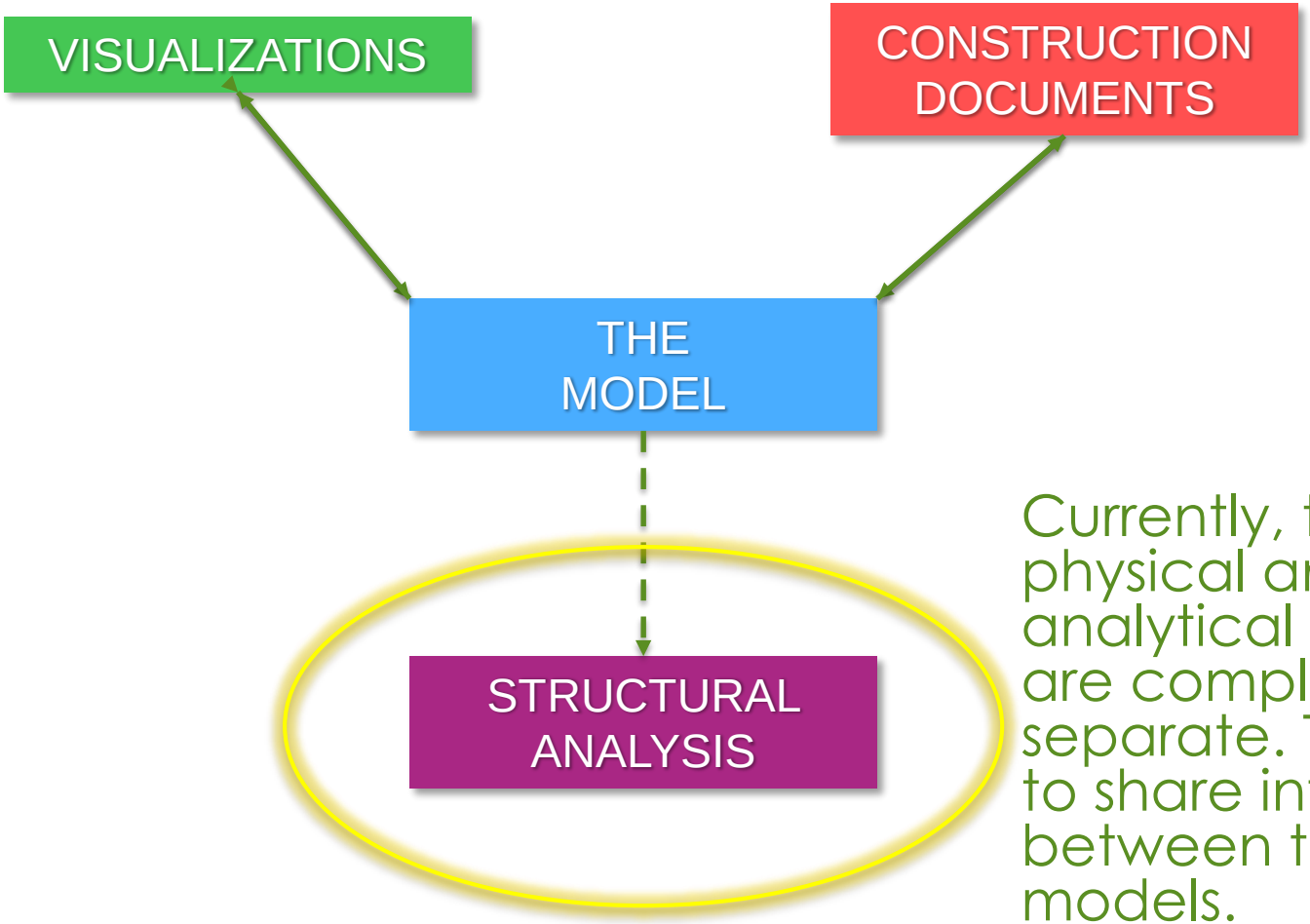
Analyses Performed

- Alternative analysis
- 3D visualization for public outreach
- 3D Central model for BIM project deliver approach

Software

- Microstation Select Series 3
- Autodesk Civil3D 2012
- Autodesk Revit
- Autodesk 3DS MAX
- Bentley Pro-Concrete

BIM PHILOSOPHY



Currently, the physical and analytical models are completely separate. The goal is to share information between the two models.

II. STRUCTURAL ANALYSIS

2 Basic Questions:

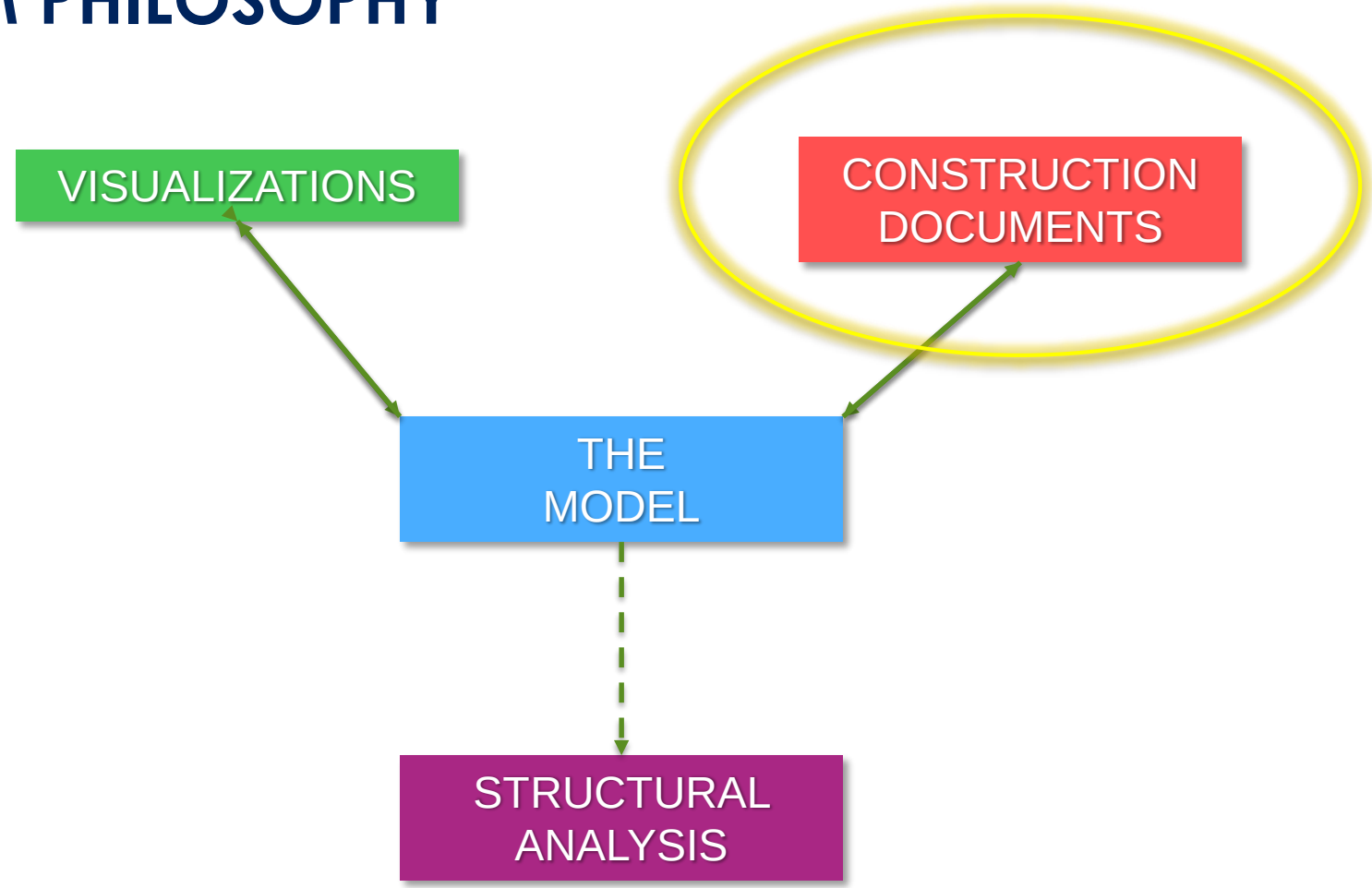
1. 2D vs. 3D Analysis?
   (influence lines or influence surfaces)
2. In-house vs. Vendor Software?

- Using the BIM Workflow, designers should develop highly detailed 3D models, which can be analyzed using vendor software.
- A model should passed to the Load Rating group and also to the Asset Management group.

Bentley Analysis Software:

- LEAP Bridge Concrete
- LEAP Bridge Steel
- RM Bridge
- LARS Bridge

BIM PHILOSOPHY



III. CONSTRUCTION DOCUMENTS

Advantages of 3D Modeling:

1. Geometrics are imported from the Roadway Design Software.
2. Models are Parametric.
3. The physical model can be tied to the analytical model.
4. The model can be visualized in the context of the site.
5. The CPM can be combined with the 3D model to produce a 4D schedule.

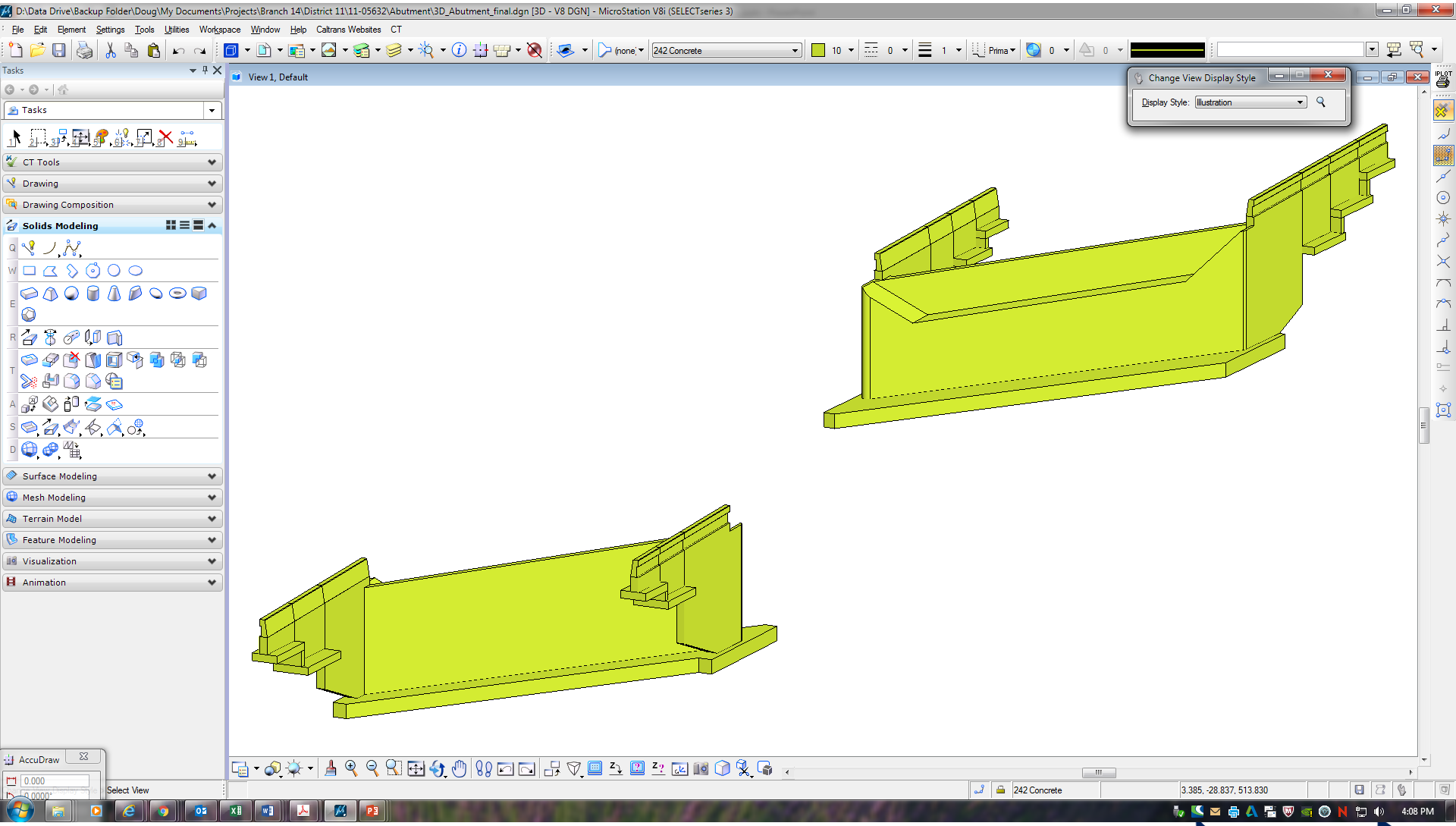
The Challenge:

Developing the future process
while continuing to deliver with the current process

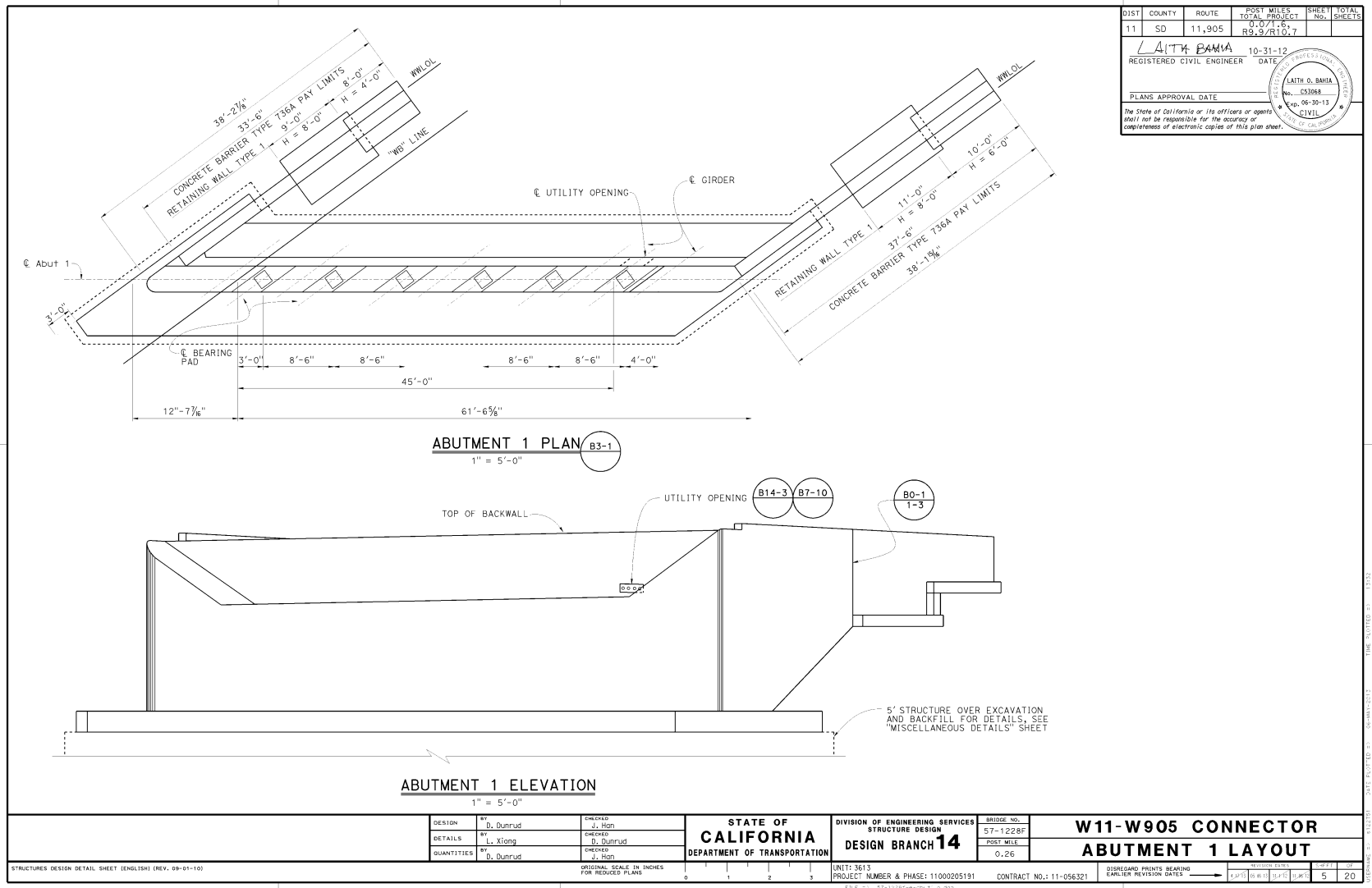
3D Modeling: is typically requested by project managers only when there is a need for visualization on complex projects.

2D CAD: is our final deliverable. Failure is not an option; project schedule cannot slip and we have to deliver with the agreed resources.

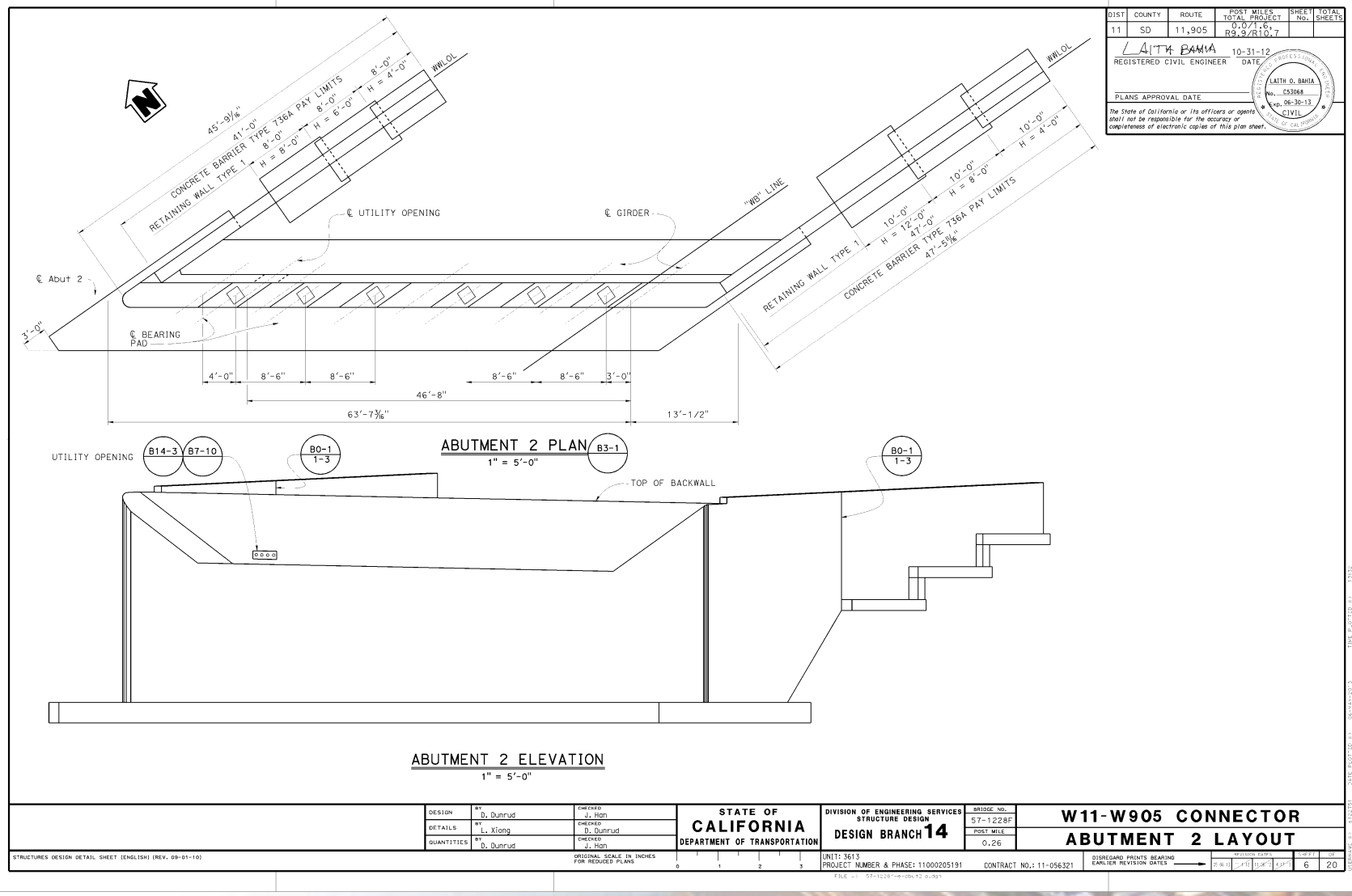
3D Microstation Example



3D Microstation Example

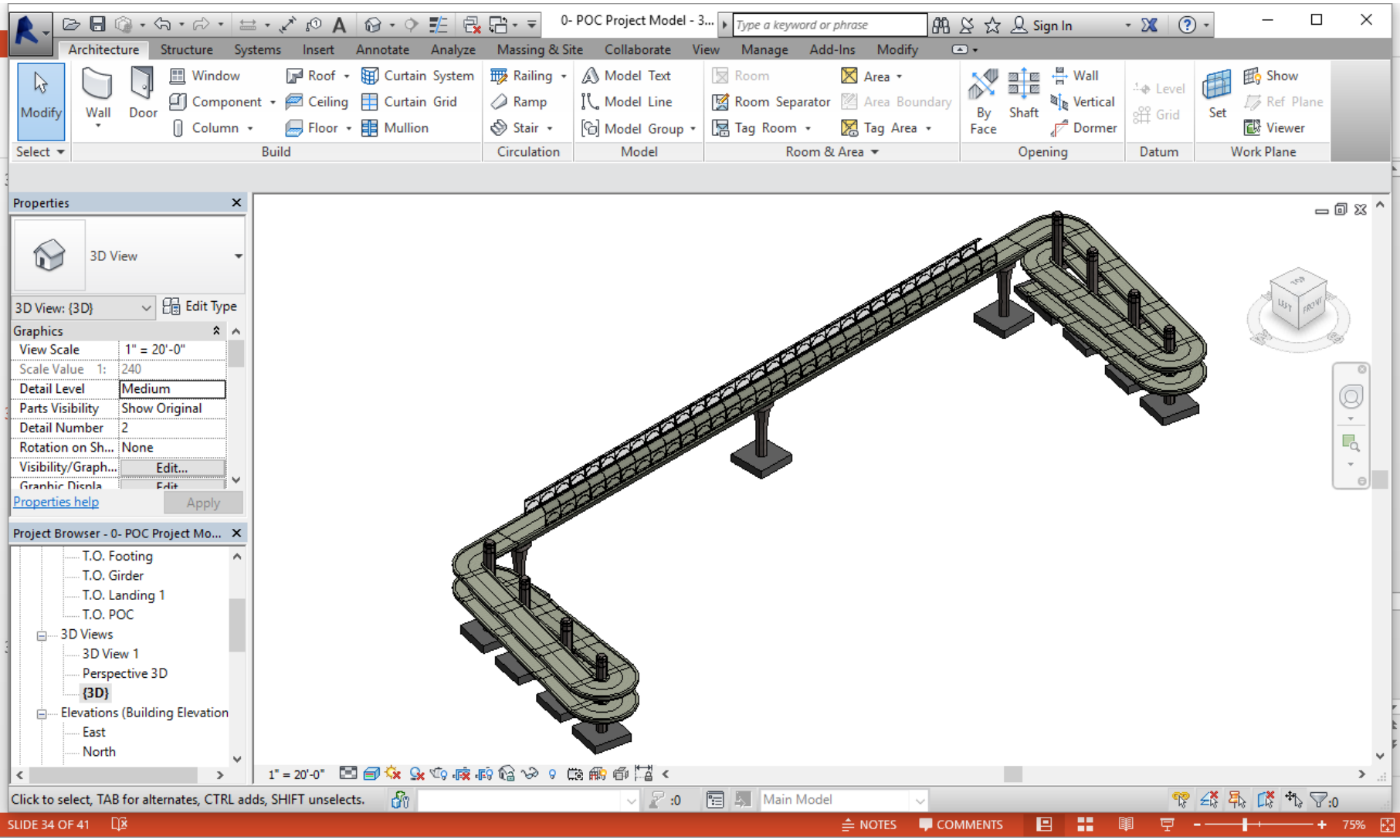


3D Microstation Example

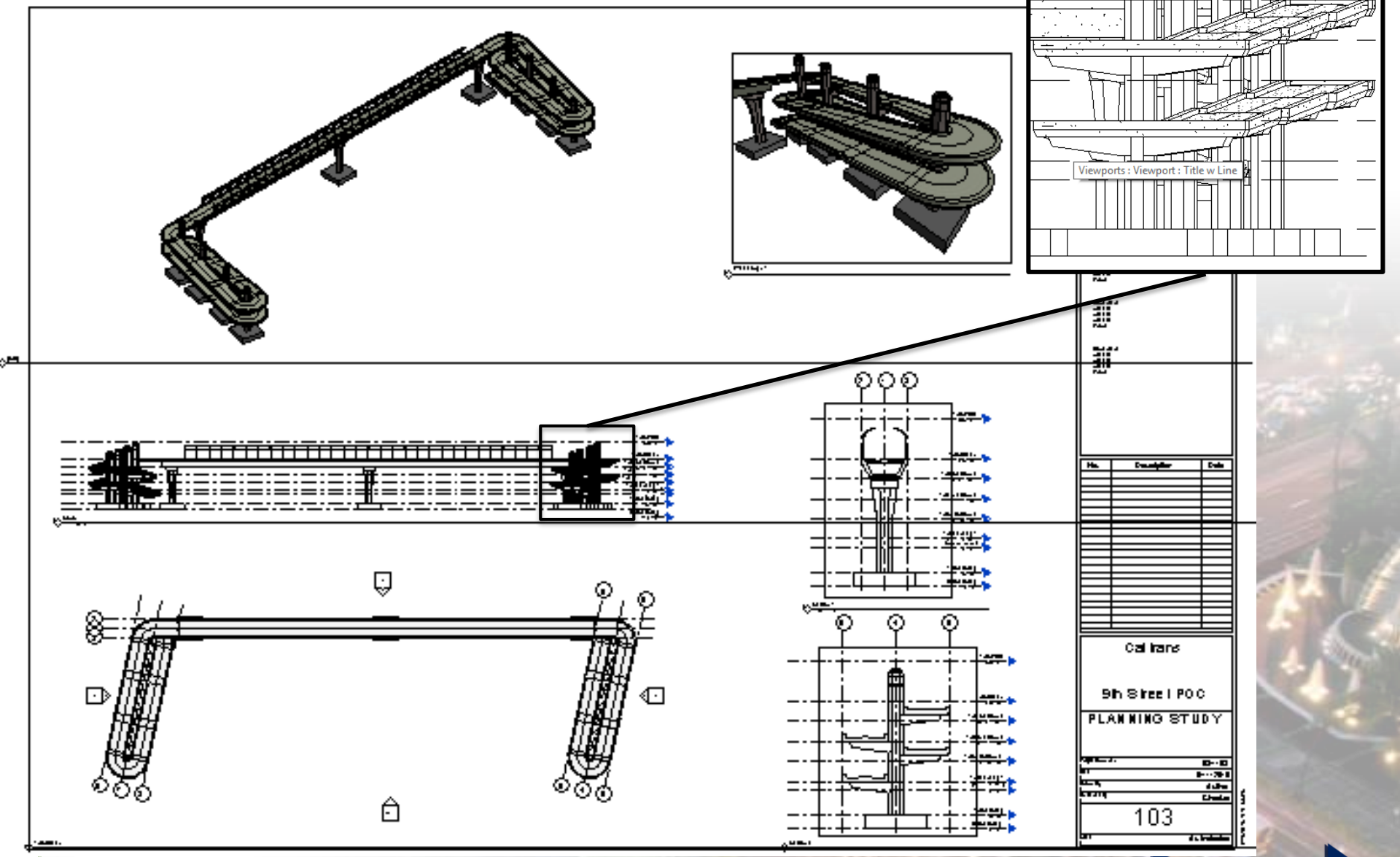


Every Day Counts

Revit Example



Revit Example



Advantages of 3D Modeling:

The model can be visualized in the context of the site.

new Otay Mesa UC 3D.kmz

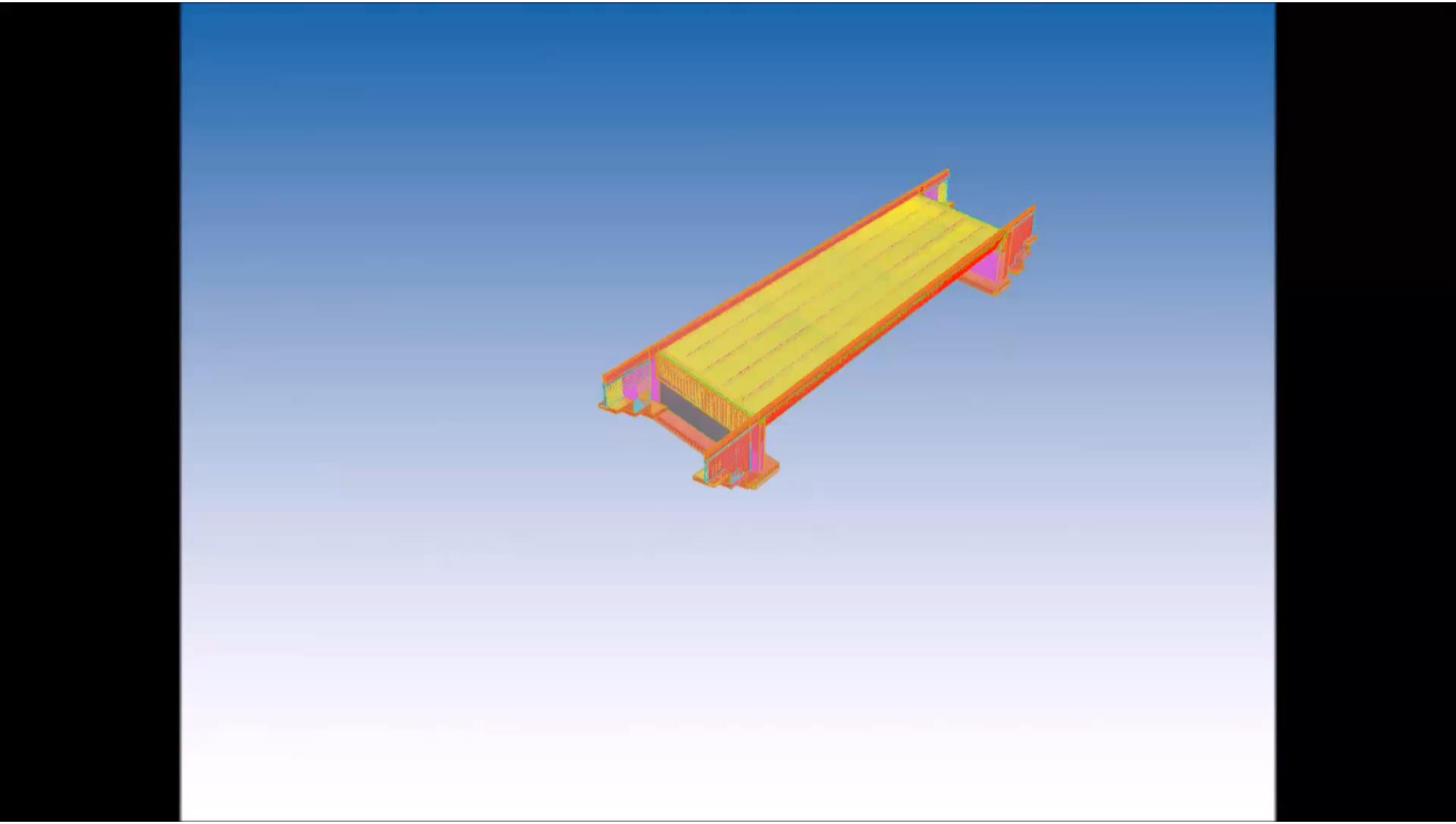
Advantages of 3D Modeling:

The CPM can be combined with the 3D model to produce a 4D schedule.

Advantages of 3D Rebar Modeling:

1. Our industry is slowly transitioning to "*Using the Model as the Contract Document*".
2. *Conflicts are identified virtually before they are encountered physically.
3. Rebar Schedules are accurate and easy to adjust.

Advantages of 3D Rebar Modeling:



2016 Bridge Industry Forum Agenda

"3D Models for Construction"

When: **Wednesday, September 14, 2016**

Where: **Caltrans, 1801 30th St. Sacramento, CA 95816**
Room 102

Meeting called by:	Michael Keever, Chief, Division of Engineering Services
Facilitator:	Douglas Dunrud, Senior Bridge Engineer, Structure Design
Purpose:	3D Bridge Models (BIM) for Construction

Time	Topic	Who
8:00 - 8:30 am	Registration	
8:30 - 8:45 am	Introduction	Michael Keever, Doug Dunrud
8:45 - 9:00 am	Introductions	Everyone
9:00 - 9:20 am	Implementing BIM for Bridges: A Case Study	Robert Allen
9:20 - 9:50 am	Rebar Detailing in the BIM World	Dennis Fontenot
9:50 - 10:15 am	4D Visual Planning for Construction Projects	Jon Berkoe/Jeff Campbell
10:15 - 10:30 am	Break	
10:30 - 10:50 am	Tekla & BIM for Bridge Projects	Alyssa Schorer/Daniella Castro
10:50 - 11:10 am	3D Models in Construction	Andre Tousignant
11:10 - 11:30 am	Revit for Structures	Shobhit Baadkar

Action Plan

1: Interoperability of supplemental electronic files

California Department of Transportation

Project Delivery Directive

Number:	PD-06
References:	*California Public Records Act (CPRA)*
Effective Date:	February 1, 2012
Supersedes:	NEW
Review by:	January 1, 2014

TITLE Sharing of Electronic Files

DIRECTIVE

Electronic copies of certain design information shall be made available to internal and external entities throughout the project delivery process for projects on the State Highway System (SHS). The sharing of electronic files aids in providing information in a cost effective and timely manner that will allow both Caltrans and its partners to deliver projects more efficiently. Therefore, providing these files will aid in improving the overall quality of the project while delivering those projects on time and within budget.

Requests for electronic files will be handled differently based on their category. Requests that do not fall within these three categories are to be handled using the guidance set forth in Deputy Directive DD-79: *California Public Records Act Compliance*.

Action Plan

2: Contractual implementation of 3D Engineered Models

51-4.01C(6) Building Information Models

Submit a BIM under the requirements for shop drawings and include a CD of the electronic file. Include the following elements in the BIM:

1. Piers (above the top of piling elevation)
2. Pier caps
3. Slab Girders
4. Deck drainage system
5. Railing anchorage

Modeling must include:

1. Actual dimensions of piers, caps, slabs
2. Profiles with fully modeled reinforcement with splice locations, prestressing strands with anchorage systems, prestressing bars with anchorage systems, dowels, and tie bars
3. Key way openings, diaphragm openings, tie rod holes, duct work, thickness of grout cover
4. Camber
5. Thickness of concrete cover, chamfers, joints
6. Lifting hardware

Action Plan

2: Contractual implementation of 3D Engineered Models

Contractors Use of 3D Models:

1. Identify and Resolve Conflicts
2. Quantities
3. Construction Work Planning (Including 4D)
4. Construction Surveying